DOCUMENT RESUME

ED 156 999 CS 004 072

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TITLE Composite Predictions of Early Reading Success.
PUB DATE Mar 78
NOTE 34p.; Paper presented at the Annual Meeting of the American Educational Research Association (Toronto, Canada, March 27-31, 1978)

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS *Beginning Reading; *Kindergarten Children; *Predictive Measurement; Predictor Variables; Primary Education; *Reading Ability; Reading Diagnosis; *Reading Readiness; *Reading Research

ABSTRACT

A functional prediction scheme was sought for use in kindergarten which would have good predictive power for future reading achievement and be easy and quick to administer and score, inexpensive, and conducive to classroom use. A group of 21 kindergarten children was tested for reading readiness, intelligence, and psycholinguistic ability. Their teachers also completed a special reading readiness checklist for each student. Results indicated that the criterion measure did not yield an assessment significantly superior to teacher judgments; the prediction ability of kindergarten teachers is better than that of teachers at any other grade level. Kindergarten teachers have access to information that is not easily codable, and a carefully constructed teacher checklist will enhance their predictive ability. A judicious combination of psychometric measures with careful teacher judgment will yield good results in prediction of reading achievement. (Tables of findings, a readiness checklist for teachers, and a complete variable list are included.) (DF)

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Composite Predictions of Early Reading Success[1]

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CS004072

Paper presented before the American Educational Research Association, Toronto, Canada, March 30, 1978.

Abstract

This paper has three objectives. First, there is a brief review of general applications of multiple regression analysis in the prediction of reading achievement. Second, an attempt was made to demonstrate the generality of special linear weighting techniques (Wainer, 1976; Dawes & Corrigan, 1974); especially "equal weighting schemes" and the derivation of a logical rule for finding "a small number of big predictors" in small samples. The third purpose was to compare equal weighting composite results with teacher estimations of probable reading achievement in an effort to throw light on the continuing "clinician vs. linear model" debate in an early reading context.

Composite Predictions of Early Reading Success

Background

There is a paucity of good studies of optimal prediction procedures of early reading achievement, and seemingly many improvements in predictions could be made, especially in small samples. Typical studies are sketchy about procedures and idiosyncratic about how they pick predictor sets and report results. Some of the better studies languish in obscurity, unrecognized for what they are.

Kapelis (1975), in one of the better studies of these issues, compared the predictive validity of two screening tests against teacher estimates of first-year reading performance for a group finishing kindergarten. Using two subtests of one screening battery resulted in a multiple prediction of reading achievement that was slightly more accurate than the teacher estimates. This study points out what is known in many other fields of the social and behavioral sciences (Dawes and Corrigan, 1974), that is, that good linear models such as multiple regression usually result in more accurate predictions of criterion levels when compared against clinical experts such as teachers who utilize the same information to make their predictions.

Others such as Lowell (1971) have investigated general reading readiness factors as predictors of success in first

grade reading. This study used two criterion measures, one administered after completion of pre-primer instruction and the other at the end of first grade. Work with semi-partial correlations in looking at each predictor as it related to total prediction would have been valuable for Lowell's purposes.

Lessler, Schoeninger, & Bridges (1970) used three measures to predict first grade reading achievement for three SES levels. Using multiple regression procedures (including semi-partial correlations) they found that the Lee-Clark Reading Readiness Test was the best single predictor. Addition of the Bender Gestalt and PPVT did not significantly improve prediction.

Brekke & Williams (1975) investigated Piagetian conservation as a predictor of reading achievement. They found that both conservation and intelligence, alone and combined, were significant predictors of reading.

Livo (1970) investigated the relation between the WPPSI, the Sartain Reading Readiness Test and a measure of oral language as predictors of reading achievement in mid-first grade. Results indicate that the Sartain had one subtest, word memory, that was a particularly efficient predictor and that the WPPSI and the Sartain were measuring different aspects of the reading process. The best predictor set for total reading achievement included total Sartain scores, word

memory subtest, sentences (WPPSI) and oral language questions. Livo points out that the 26 subtests that were administered measured auditory discrimination, visual discrimination, IQ factors and oral language maturity. These variables accounted for only 45 percent of criterion variance.

It appears that even some of the most sophisticated of standardized measures are not tapping a good deal of what is known as "reading achievement." Obviously such hard-to-measure variables as motivation, work habits, enjoyment of reading, willingness to read and teacher expectations and attitudes would need to be included in any complete predictor set that purported to measure total reading achievement. Jansky and deHirsch (1972) point out these intangible variables are "hazards to prediction" (60). Pikulski (1974) has pointed out another of the pitfalls of prediction--the nature of the child's instructional materials. The range of published reading programs is very large and no one criterion measure matches this variation. Schools, children, teachers and classrooms vary enormously too, and for example, St. John (1971) has identified the need for anthropology's observational tools for really adequate descriptions of these situations.

When there is a local focus for prediction, for example, in particular classrooms of N = 25, is there any hope of applying our sophisticated multivariate regression model

with any success in such limited confines? Traditionally, the answer has been no, but recently some hybrid procedures have been constructed that look promising. Wainer (1976), Dawes and Corrigan (1974), and Einhorn and Hogarth (1975) have shown that equal weights used in the simplest kind of regression models under general conditions perform as well as or better than traditional regression coefficients (betas) in new samples. They also point out a large body of literature that show linear models always out-predict human judges using the same background information, in the "clinical vs. statistical" controversy. The problem appears to be how to get a stable prediction scheme going in small sample settings such as that available to reading specialists in schools. Wainer makes the point that when using unit weights, sample size is not critical, although here he differs with Einhorn and Hogarth (1975) who advocate solved beta weights if large samples (e.g., $N > 100$) are available. Strategies for applying unit weights to a small set of predictors were tried out in three separate settings.

Procedure

The initial sample consisted of 21 children (12 male, 9 female) attending two schools in a suburban setting. All children were from middle to upper-middle socio-economic class. During the spring of their kindergarten year, each

child was individually tested by trained graduate students using the following battery of psychometric and achievement measures: Wechsler Preschool and Primary Scale of Intelligence (WPPSI), Illinois Test of Psycholinguistic, Ability (ITPA), Metropolitan Reading Readiness Test, and the deHirsch Screening Index.

In addition to these measures, kindergarten teachers were asked to fill out a specifically designed readiness checklist consisting of 45 questions in 11 areas; the checklist yielded an additional three variables.[2] Children were tested on the Delaware Educational Assessment Program (DEAP) in the spring of their first-grade year and the standard reading score from the DEAP served as the criterion measure. Altogether a total of 44 independent variables were available to be used as predictors of first grade reading achievement.

The second of the stated purposes for this study was to look at the advice of Wainer and Dawes and Corrigan and see if it had applicability to a "real-life" situation in which a great deal of information was available on very few children. It was hoped that out of so many independent variables, a scheme for functional prediction would be forthcoming. Functional for the purposes of this paper meant tests that were easy to give and score, quick to administer, inexpensive, conducive to use by a classroom teacher, and had good predictive power when simply unit weighted and then

correlated with the criterion. Good prediction was chosen to be an R with the criterion $\geq$ .60. This "multiple R" is arbitrary and accounts for less than 40 percent of the variability in future reading achievement. Earlier work with this data (N = 21) had shown that the Total Teacher Estimate score was the most highly correlated single variable with the criterion, r = .68. The third purpose of this study is to examine reasons why teacher prediction at early levels might be an exception to invariable findings in clinical psychology and college admissions that linear models outperform human judgment.

A comment here is necessary in regard to the number of variables in relation to number of subjects. The recommended ratio is approximately 30 subjects for each independent variable in regression analysis (Kerlinger & Pedhazur, 282). This is to insure stable results in cross-validation work. The R calculated in the original sample will nearly always be larger than that found in a cross-validation sample because the zero-order correlations are treated as if they were error-free, but errors normally lower the efficiency of the weighted set in subsequent analyses. This results in an excessive "goodness of fit" in all first sample settings. Wherry (1975) has discussed the long history of the problem in some entertaining detail. One of the advantages of unit-weighting is that it has been shown that equal weighting does as well or better than optimal weighting when used in a new

small sample (Dawes and Corrigan, 1974). Other reasons for using equal weights are: insensitivity to outliers, ease of estimation, and no "using up" degrees of freedom (Wainer, 1975, p. 213). The focus for our work was thus procedures for obtaining brief sets of predictors which seemed to produce optimal unit-weighted composites.

Multiple correlation and unit weighting analyses were done using SPSS (Nie, et al., 1975). The use of the COMPUTE convention allowed unit-weighted composites to be constructe through linear transformation: Independent variable scores were changed to z-scores then simply summed. This yielded a grand Z composite which was then compared against the correlation of teacher prediction with the criterion and with the multiple correlation discussed earlier. Three such composites were constructed: The first consisted of those variables which had separately been identified as entering the step-wise regression analysis first--the "small number of big predictors" advocated by Dawes and Corrigan. The second consisted only of total or global scores from each of the psychometric tests on hand, as it was felt that such scores were very robust. The third was the "functional" set discussed earlier, which emphasized a short list of unit-weighted predictors that would be very easy for reading specialists to use in practice.

Results

The first set of computer runs for each set yielded the following results, where the Mult R column indicates the unit weighted sum's correlation with the criterion.

Insert Table 1 about here

None of the composites exceeded the criteria set earlier: GRZ with criterion .60. Attempts of an intuitive nature to rework the composites did not prove useful. The results of the functional and global composites were particularly disappointing. It was felt that high individual correlation with the criterion and low correlation with the composite would identify the most useful predictors as has been traditional in multiple correlation, but it did not. Finally, the three sets of predictors were recombined in a single set and the intercorrelation matrix examined (see Appendix B). New brief composites were constructed and tried out, and finally the results in Table 2 were obtained using only four variables.

Insert Table 2 about here

The unit-weighted composite exceeded both the arbitrary $R \geq .60$ and the correlation between teacher prediction and criterion = .68. The basis for selecting the best variables for unit weighting was as follows: Intercorrelations among such unit

weighted variables should be less than .40 and correlation with the criterion should be at least .20 but less than .55. Anything in this range appears to produce a high R while violations of either part of the rule lowers the R.

Cross-validation of such a procedure offers proof of the pudding. After the initial sample data was analyzed a screening battery was devised containing six psychometic measures, among them the three variables discussed in the "big predictor" composite above. This battery, along with the teacher checklist was administered to two groups of kindergarten children (Ns = 56, 77) during the following academic year, who came from similar backgrounds in the same school district. Predicted shrinkage for the multiple correlation coefficient in the second sample was .47. The actual correlation of the new composite found by applying the above rule identified V03, V04, and V05 as the best combination for this new sample. The correlation of this newly identified composite with the criterion was equal to .69 which is not significantly lower than the correlation in the original sample (.73). In the third sample expected shrinkage was again .47 and the actual correlation was .58. Adding in teacher prediction to the composite raised the correlations significantly in the first and third samples to R = .70 and .71 respectively. These results are summarized in Table 3 and 4.

Insert Table 3 about here

Insert Table 4 about here

Discussion

Perhaps the failure of the global predictors in the initial sample to produce a good composite was their high correlation with the composite (4 out of 5 variables $\geq .70$). This indicates that these variables are tapping the same kinds of ability. The composite battery is not terribly complex in terms of cost and administration. The moderate intercorrelations of the variables indicate that they are each contributing somewhat independently to criterion variance. All of the measures used could be used by a reading teacher within natural school settings.

As mentioned earlier, the correlation in the initial sample between teacher prediction and the criterion measure = .68. Although the final composite yielded an R = .74, the writer does not feel this is significantly superior to teacher judgment. The ability of kindergarten teachers to predict success in later achievement is greater than at any other grade level. These teachers are usually developmentally oriented and they do have access to information that is not

easily codable. In these aspects, their judgment is very close to that of a good clinician. It appears that a judicious mix of psychometric measures and careful teacher judgment yield results which are useful and meaningful.

The rule devised for composite construction is based on using predictors which tap differing kinds of criterion variance. This is achieved by using predictors which are slightly correlated with each other and moderately correlated with the criterion.

Before adopting a screening battery such as that described more work would need to be done in validating this selection procedure in differing SES groups. The robustness of unit-weighting in small samples has been shown by the strength of the correlation coefficients in cross-validation work. Shrinkage was not nearly as great as one would expect using solved beta weights from an initial sample. Indeed, the composites involving teacher prediction in samples one and three are functionally equal to those obtained by using solved beta weights.

Summary

The purposes of this study were: 1) to review articles dealing with multiple regression in predicting reading achievement, and 2) develop a scheme for constructing robust

composites. This was done and robustness demonstrated in cross-validation samples. The third issue of clinical vs. linear model efficiency was examined in this reading specialist context. Such clinician's judgments were poorer than the unit-weighted model in sample 2 only.

Combining teacher estimates seems to boost composite results. This suggests to the reading specialist that kindergarten teachers possess information that does not lend itself to codable input measured by traditional psychometric tasks, and that a carefully constructed teacher checklist will enhance predictive ability.

Reference Notes

1. Acknowledgement of thanks is due Professor John Pikulski, Reading Study Center, University of Delaware, for extending the use of these data which were collected earlier for slightly different purposes.
2. The readiness checklist has since been factor analyzed. Time prohibited by including the results in this study. A copy is attached.
3. Wainer, 213.
4. Jansky and deHirsch (1972), Bliesmer (1952) cited in Jansky and deHirsch, 30.

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Table 1

Relative Efficacy of Predictor Selection Strategies with Unit-Weighted Composites

	Predictor Sets	p.c	$r_{p.GRZ}$	Mult R GRZ With DEAP Criterion
1. Step-wise: Small # of big predictors	V29 - Metro total	.39	.56	
	V22 - Visual assoc.	.19	.82	
	V04 - WPPSI info.	.43	.78	.60
	V33 - Metro alpha	.23	.0089	
	V03 - WPPSI VIQ	.53	.79	
2. Globals	V03 - WPPSI VIQ	.53	.70	
	V10 - WPPSI PIQ	.20	.85	
	V16 - ITPA PLA	.25	.72	.42
	V29 - Metro. total	.39	.70	
	V36 - deHirsch total	.01	.24	
3. Functional	V04 - WPPSI info.	.43	.60	
	V22 - ITPA vis. assoc.	.19	.56	
	V33 - Metro alpha	.23	.14	.51
	V39 - Gates WM	.21	.47	
	V41 - Sentences-deHirsch	.08	.45	

Table 2

Step-Wise Production of Optimally-Composed Composite N = 21

GRZ With Criterion = .74

	Variable	Mult R	R^2	Change in R^2	F	Significant .05
Step 1	03 WPPSI VIQ	.535	.286	.286	14.866	yes
Step 2	33 Metro alpha	.717	.514	.228	12.943	yes
Step 3	29 Metro total	.770	.593	.078	3.229	yes
Step 4	39 Gates WM	.805	.648	.055	2.506	no

Note: V03 + V33 + V29 + V39 = GRZ. This unit-weighted composite differs in efficiency only fractionally when compared with "solved" weights, i.e., R_{GRZ} = .74 while true Mult R = .80.

Table 3

Comparisons of Unit-Weighting and Traditional Weighting Across Samples

Sample #	Unit-Weights				Traditional Weights (∝.05: Maximum significant step reached)			
	Without Teacher Prediction		With Teacher Prediction		Without Teacher Prediction		With Teacher Prediction	
1	$R_{GRZ.C}$	R^2	$R_{GRZ.C}$	R^2	Mult R	R^2	Mult R	R^2
N=21	.60	.36	.86	.74			.68	.46
2								
N=56	.69	.47	.70	.49	.73	.54	.74	.55
Predicted shrinkage: .47								
3								
N=77	.58	.33	.71	.50	.63	.40	.75	.56
Predicted shrinkage: .47								

Table 4

Intercorrelation Matrix--Second and Third Samples

(Separate applications of the procedures to find the best composite)

Sample 2: Variables in the composite: V03 - Gates WM - V04 WPPI Info. - V05 - Metro alpha

	V03	V04	V05	TP	CR
V03	1.00	.29	.40	.46	.45
V04		1.00	.39	.67	.60
V05			1.00	.61	.54
TP				1.00	.60
CR					1.00

GRZ w/ Criterion without TP: R = .69 R^2 = .47

GRZ w/ Criterion with TP: R = .70 R^2 = .49

N = 56

Sample 3: Variables in the composite: V03 - Gates WM - V04 WPPSI Info. - V05 Metro alpha

	V03	V04	V05	TP	CR
V03	1.00	.45	.31	.48	.39
V04		1.00	.36	.53	.43
V05			1.00	.56	.52
TP				1.00	.68
CR					1.00

GRZ w/ Criterion without TP: R = .58 R^2 = .34

GRZ w/ Criterion with TP: R = .71 R^2 = .50

N = 77

Appendix A

Comparison of B's Before & After Unit-Weighting

	Variable	Traditionally Weighted Raw Score B's	Unit Weighted B's	
03	WPPSI VIQ	.25	.64	all within the .25-.75 range advocated by Wainer
33	Metro alpha	2.77	.60	
29	Metro total	.19	...	
39	Gates WM	.50	.25	

Sample 1

APPENDIX B

Intercorrelation Matrix

	03	04	10	16	22	29	33	36	39	41
03	1.00	.85	.53	.65	.65	.25	-.38	-.15	.23	-.06
04		1.00	.33	.53	.60	.09	-.21	-.30	.16	-.18
10			1.00	.51	.69	.70	-.46	.02	.19	.00
16				1.00	.59	.28	-.37	-.11	.10	-.07
22					1.00	.44	-.24	-.25	.06	-.13
29						1.00	-.13	.05	.11	.07
33							1.00	.05	-.35	.13
36								1.00	.30	.77
39									1.00	.20
41										1.00

r with criterion

03	WPPSI VIQ	.53
04	WPPSI INFO	.43
10	WPPSI PIQ	.20
16	ITPA PLA	.25
22	ITPA Vis. Assc.	.20
29	Metro. total	.39
33	Meto. Alpha	.23
36	deHirsch Total	-.02
39	Gates WM	.22
41	Sentences	.08

APPENDIX C

Predictor and Criterion Measures by Author

Author	Criterion	Predictors
Brekke & Williams	Gates-MacGinitee	- Gates-Macgintie Reading Tests-Readiness - S&A Primary Mental Ability Gr. K-1 - conservation measures
Kapelis	reading subtests of Primary 1 Battery, Metropolitan Ach. Tests	- Meeting School Screening Test - Slingerland Prereading Screening Procedures (Totals & subtests) - Teacher judgement (not clear what was included here)
Lowell	Pre-primer word rec. Diagnostic Reading Scales	- Murphey Durrell Reading Readiness Analysis (1965) - *Lee-Clark Reading Readiness Test (Revised) - Test of General Ability Form A, Gr. K-1 - Visual subtest Murphey-Durrell (1949)
Lessler, et al.	California Reading Test Teachers' Ratings	- Peabody Picture Vocabulary Test - *Lee-Clark Reading Readiness Test - Bender-Gestalt Test
Livo	Metropolitan Achievement Test	- WPPSI - Sartain Reading Readiness Test - Oral language sample

*It is interesting to note that Lowell's point about common agreement of what is important to measure is nicely illustrated in this review. Fifteen different predictors are used with only one measure of prediction (Lee-Clark) being used twice.

Complete Variable List

01 CA in months
02 WPPSI Full Scale IQ
03 WPPSI Verbal IQ
04 WPPSI Information
05 WPPSI Vocabulary
06 WPPSI Arithmatic
07 WPPSI Similarities
08 WPPSI Comprehension
09 WPPSI Sentences
10 WPPSI Performance IQ
11 WPPSI Animal House
12 WPPSI Picture Completion
13 WPPSI Mazes
14 WPPSI Geometric Design
15 WPPSI Block Design
16 ITPA Psycholinguistic Age (months)
17 ITPA AuditoryReception
18 ITPA Visual Reception
19 ITPA Visual Memory
20 ITPA Auditory Association
21 ITPA Auditory Memory
22 ITPA Visual Association
23 ITPA Visual Closure
24 ITPA Verbal Expression
25 ITPA Grammatic Closure

26 ITPA Manual Expression

27 ITPA Auditory Closure

28 ITPA Sound Blending

29 Metropolitan Total

30 Metropolitan Word Meaning

31 Metropolitan Listening

32 Metropolitan Matching

33 Metropolitan Alphabet

34 Metropolitan Numbers

35 Metropolitan Copying

36 deHirsch Total

37 deHirsch Letter Naming

38 deHirsch Picture Naming

39 deHirsch Gates Word Matching

40 deHirsch Bender Design

41 deHirsch Sentence Memory

42 Teacher rating total

43 Teacher rating general

44 Teacher rating overall

45 DEAP reading scores--1st grade--CRITERION

A.I.D. READINESS CHECKLIST FOR KINDERGARTEN TEACHERS

Student's Name _____

Teacher's Name _____

Scale: 1 = Very significantly below average; 2 = Slightly weak; 3 = Adequate (Average); 4 = Slightly above average; 5 = Outstanding	
1 2 3 4 5 I.	Background of Experience and Concept Development
1 2 3 4 5	1. Familiarity with common experiences and ideas. Places (grocery, post office, travel experiences), People (policemen, truck drivers, farmers), Basic concepts (above, below, different, same, larger, in-between, twice).
1 2 3 4 5	2. Familiarity with children's stories, songs, nursery rhymes.
1 2 3 4 5	3. Familiarity with numerical, social, scientific, political, etc., concepts (more, less, 10, a hundred, friends, family, how things work, weather concepts, president, elect.).
1 2 3 4 5 II.	Listening Skills
1 2 3 4 5	4. Ability to understand directions when given initially (get out the scissors, etc.)
1 2 3 4 5	5. Can repeat simple sentences or directions (understanding and memory).
1 2 3 4 5	6. Can repeat stories so as to reflect main ideas and important sequence.
1 2 3 4 5	7. Memorizes songs, poems, stories (either from home or school).
1 2 3 4 5 III.	Oral Language Skills
1 2 3 4 5	8. Vocabulary (number of different words he uses).
1 2 3 4 5	9. Maturity of sentence structure (complete sentences, sentence complexity).
1 2 3 4 5	10. Language facility (ability to use words freely, readily expresses self) and clarity of speech (does not distort speech sounds, absence of baby talk).
1 2 3 4 5	11. Ability to express needs, ideas, etc. (ability to combine the skills listed above).
1 2 3 4 5 IV.	Thinking Skills
1 2 3 4 5	12. Ability to predict outcomes (eg. on basis of title has idea of story contents, can finish a story once it's begun).
1 2 3 4 5	13. Approaches problems in systematic fashion (goes beyond trial and error).
1 2 3 4 5	14. Relates new ideas to past experiences and generalizes from one situation to another.
1 2 3 4 5	15. Sees sequence (eg. in series of pictures).
1 2 3 4 5 V.	Interest in Reading
1 2 3 4 5	16. Shows interest in being read to.
1 2 3 4 5	17. Enjoys looking at books.
1 2 3 4 5	18. Eager to learn to read.
1 2 3 4 5	19. Asks what letters and words mean.

1	2	3	4	5	VI.	Social-Emotional Adjustment
1	2	3	4	5		20. Relationship with other children (plays with others, is accepted by co-workers as part of group).
1	2	3	4	5		21. Reactions to adult figures (can accept direction, respond to assigned tasks and is not overly dependent).
1	2	3	4	5		22. Ability to work independently and persist in a task, and take initiative.
1	2	3	4	5		23. Impulse control.
1	2	3	4	5		24. Positive self-image.
1	2	3	4	5		25. Ability to assume a leadership role.
1	2	3	4	5		26. Ability to set realistic goals.
1	2	3	4	5		27. Adequate home relationship (over protected, quarrelling with brothers and sisters).
1	2	3	4	5	VII.	Auditory Discrimination Skills
1	2	3	4	5		28. Can distinguish gross differences in sound (bell vs. cows moo).
1	2	3	4	5		29. Can identify and reproduce rhythm patterns (clapping hands).
1	2	3	4	5		30. Can distinguish between similar sounding words (tells if words are same or different, if rhyme or not, if begins same way or not).
1	2	3	4	5		31. Can give illustrations of particular sound elements (can give rhyming words, words that begin with same sound).
1	2	3	4	5	VIII.	Visual Perception Skills
1	2	3	4	5		32. Can see similarities and differences in pictures and simple geometric forms.
1	2	3	4	5		33. Can see similarities and differences in letters.
1	2	3	4	5		34. Can name individual letters.
1	2	3	4	5		35. Ability to recognize words.
1	2	3	4	5	IX.	Fine Motor Skills
1	2	3	4	5		36. Ability to grasp the pencil.
1	2	3	4	5		37. Consistently chooses to use the same hand.
1	2	3	4	5		38. Ability to copy letters.
1	2	3	4	5		39. Ability to write name.
1	2	3	4	5	X.	Gross Motor Skill
1	2	3	4	5		40. As displayed in playground activities and in walking, running, and skipping.
1	2	3	4	5	XI.	Related Physical Factors
1	2	3	4	5		41. Ability to use near and far point vision.
1	2	3	4	5		42. Ability to hear speech at a normal volume within a classroom situation.
1	2	3	4	5		43. General physical maturity (size, muscle development).
1	2	3	4	5		44. General health (overweight, underweight, pale, listless).
1	2	3	4	5		45. Attendance Record.

Overall rating of readiness for initial reading

1 2 3 4 5 6 7 8 9 10

From : Reading Study Center
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